Critical GWFM Evaluation Questions

1. What is the model going to be used for?
2. Do we have confidence that the model results are informative for that purpose?

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Comparative Chemistry

Chemical Parameter	Red Hill Shaft	Dike Zone Recharged *	Moanalua**	
Chloride	95 73-130	37	82 (57-123)	
$\delta^{18}O$	-3.2 & -3.0	-3.1	-3.1 (-2.8 to -3.2)	RHS samples 1/9/17 & 4/23/20
$\delta^{15}N$	5.28	3.99	6.74 (6.15 & 7.33)	Natural dissolve N $\delta^{15}N$ ~ 2-3 $^{o}/_{oo}$
$\delta^{34}S$	16.2	19.4	18.0 17.2 & 18.8	~18-19 $^{o}/_{oo}$ seems to be a normal range Seawater S ~ 20 $^{o}/_{oo}$
Fluoride	0.24 & 0.07 & 0.07	0.02	0.03 (0.02-0.05)	RHS Samples 11/14/16 & 1/9/17

* Kamehameha School A well, upslope on Kalama Ridge

** Moanalu Wells 2&3, Tripler Army Medical Center Supply Well, Honolulu Int'l Country Club Well

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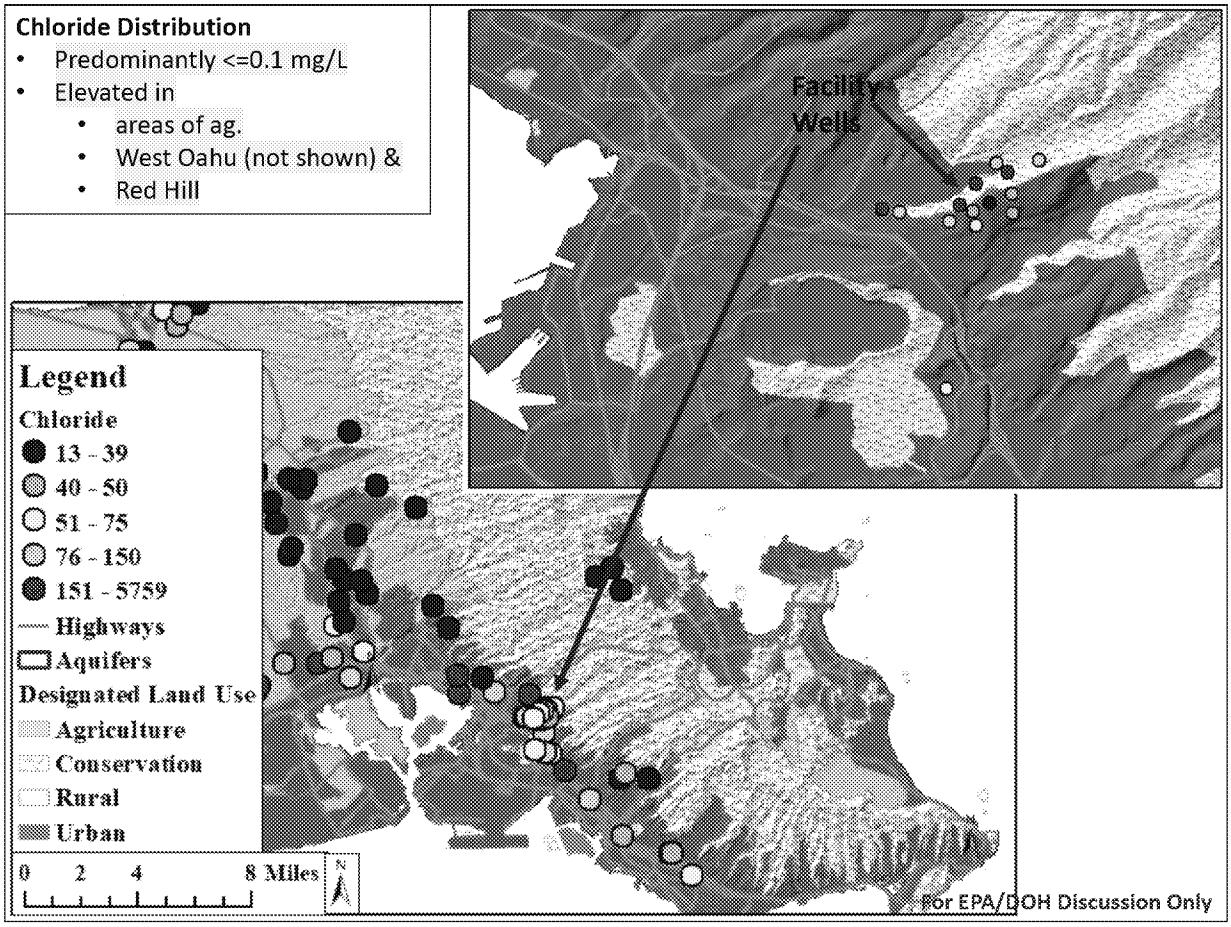
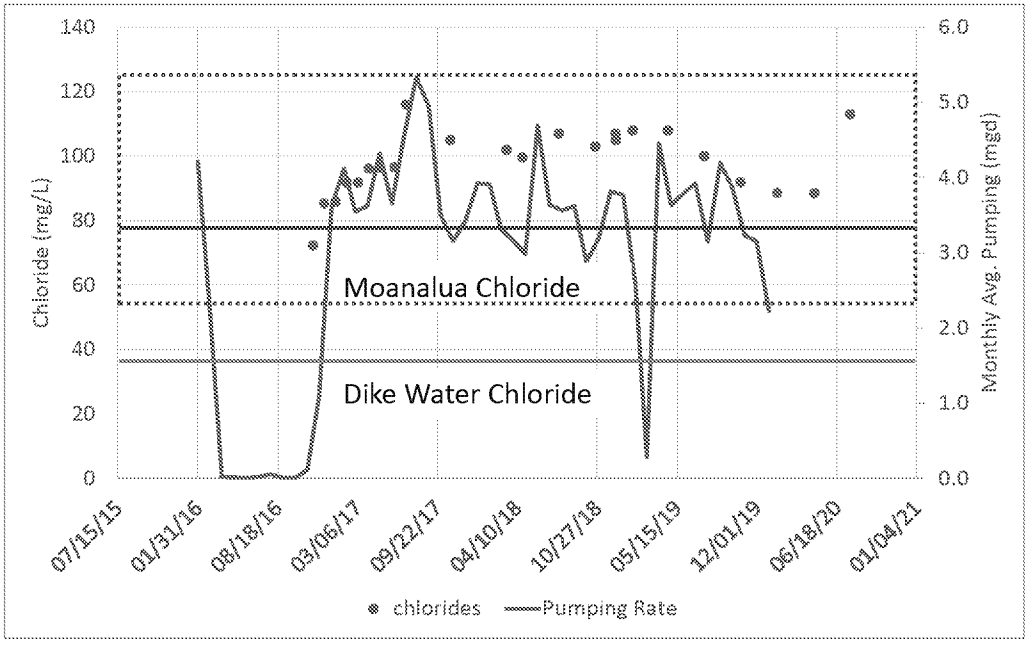

Chloride Distribution
• Predominantly <=0.1 mg/L
• Elevated in
• areas of ag.
• West Oahu (not shown) &
• Red Hill
Facility Wells
Legend
Chloride
13 - 39
40 - 50
51 - 75
76 - 150
151 - 5759
Highways
Aquifers
Designated Land Use
Agriculture
Conservation
Rural
Urban
0 2 4 8 Miles
N
For EPA/DOH Discussion Only



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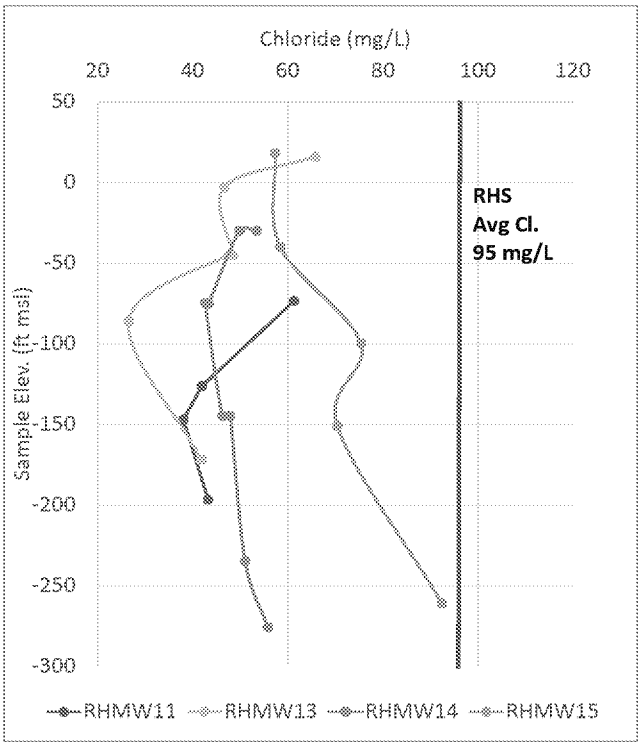
Incorporating Geochemistry w/o Doing a Transport Model

- Mixing Equation
  - $C_{mix}=(C_1*Q_1+C_2*Q_2+C_3*Q_3)/(Q_1+Q_2+Q_3)$
- Modeled inflow to Red Hill Shaft
  - Deep dike water – 39%; Cl=37 mg/L
  - Moanalua Water – 59%; Cl = 82 mg/L
  - Direct Recharge – 2%; Cl = 25 mg/L
- C_{mix} Calculated – 63 mg/L
- C_{mix} measured - ~95 mg/L
- I believe the inflow percentages were for a RHS non-pumping condition
  - If I recall right majority of modeled inflow during pumping was deep dike water.

Westbay Well Chlorides



- Upslope or west of the Red Hill Shaft all Cl<< RHS Cl_{avg} of 95 mg/L
- Low Cl in RHMW11, 13, & 14 argue against upflow from HDMW2253 as the source of Cl
- In RHMW15 (near the east end of the RHS infiltration gallery) the chlorides start to approach RHS values between -150 & -260
  - However, water levels indicate a downward gradient

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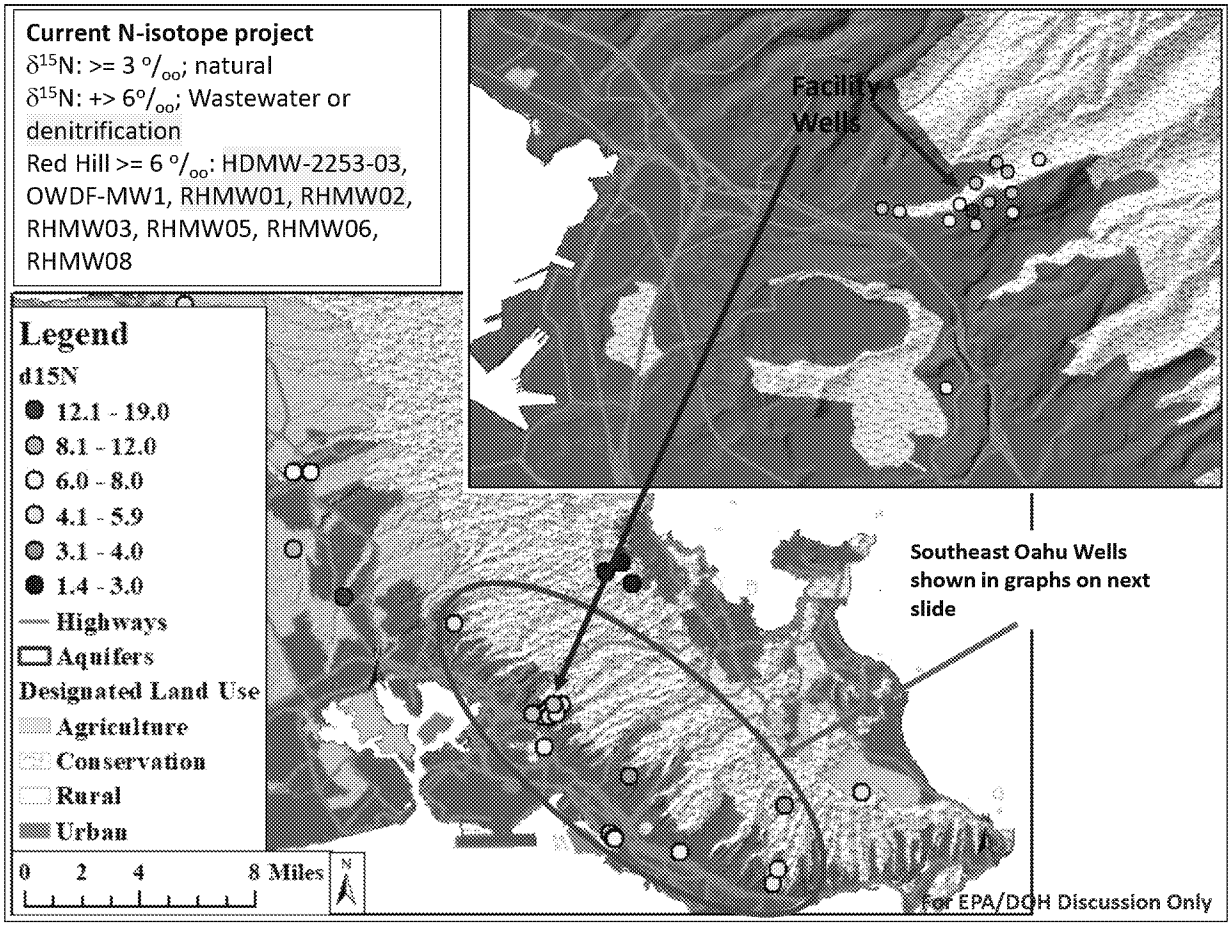
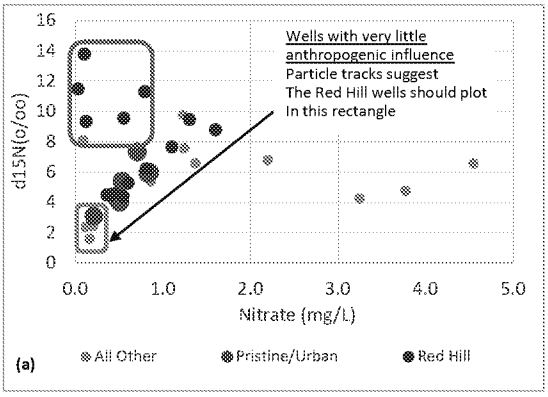
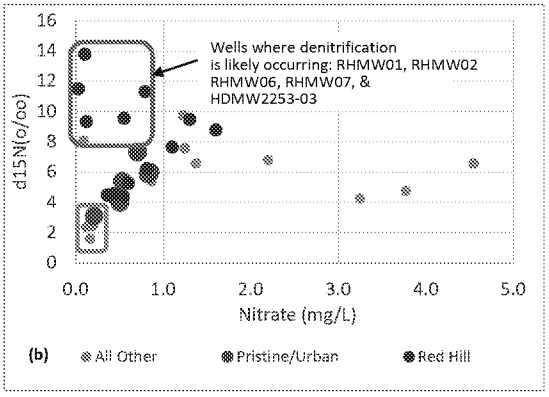
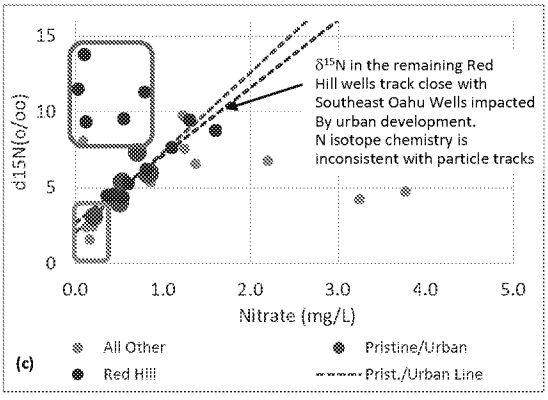

Current N-isotope project
δ15N: >= 3 °/oo; natural
δ15N: +> 6°/oo; Wastewater or denitrification
Red Hill >= 6 °/oo: HDMW-2253-03, OWDF-MW1, RHMW01, RHMW02, RHMW03, RHMW05, RHMW06, RHMW08
Facility Wells
Southeast Oahu Wells shown in graphs on next slide
Legend
d15N
12.1 - 19.0
8.1 - 12.0
6.0 - 8.0
4.1 - 5.9
3.1 - 4.0
1.4 - 3.0
Highways
Aquifers
Designated Land Use
Agriculture
Conservation
Rural
Urban
0 2 4 8 Miles
N
For EPA/DOH Discussion Only







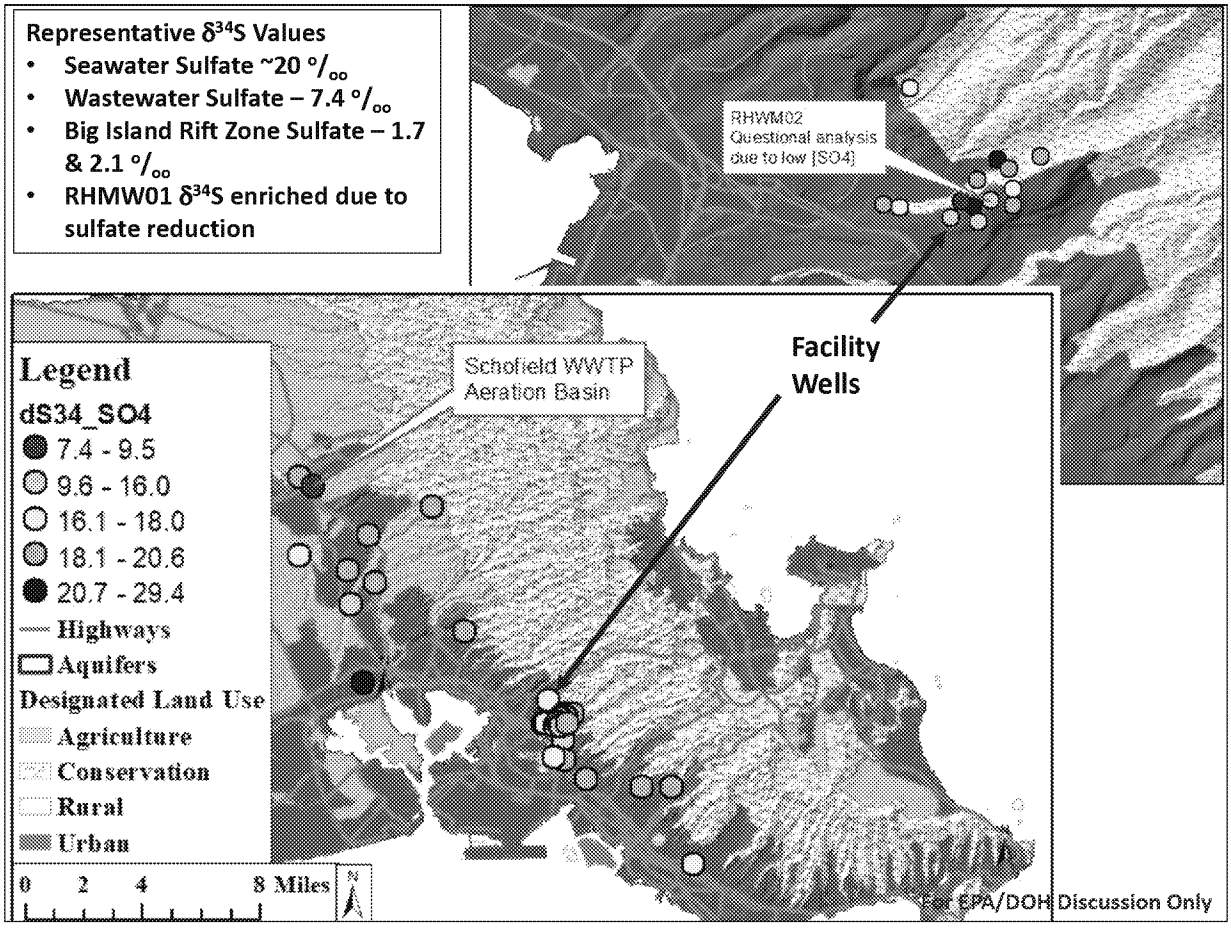
Groundwater nitrate appears to have an isotopic to nitrate enrichment relationship that correlates with the degree of anthropogenic influence on the groundwater.

- These graphs shows the nitrate vs. d15N for groundwater samples collected on Oahu. The nitrogen isotope chemistry includes pristine areas, groundwater samples where denitrification is likely occurring, groundwater impacted by urban development.

a) Graph (a) shows the isotopic composition of groundwater not impacted by urban development.

b) Graph (b) shows the Red Hills showing denitrification due natural attenuation of hydrocarbons.

c) Graph (c) shows the close relationship between the trend of the remaining Red Hill wells nitrate chemistry and that of the urban southeast Oahu wells **suggesting cross-aquifer flow to Red Hill**.


Representative δ34S Values
• Seawater Sulfate ~20 °/oo
• Wastewater Sulfate – 7.4 °/oo
• Big Island Rift Zone Sulfate – 1.7 & 2.1 °/oo
• RHMW01 δ34S enriched due to sulfate reduction
RHWM02
Questional analysis due to low [SO4]
Facility Wells
Schofield WWTP Aeration Basin
Legend
dS34_SO4
7.4 - 9.5
9.6 - 16.0
16.1 - 18.0
18.1 - 20.6
20.7 - 29.4
Highways
Aquifers
Designated Land Use
Agriculture
Conservation
Rural
Urban
0 2 4 8 Miles
N
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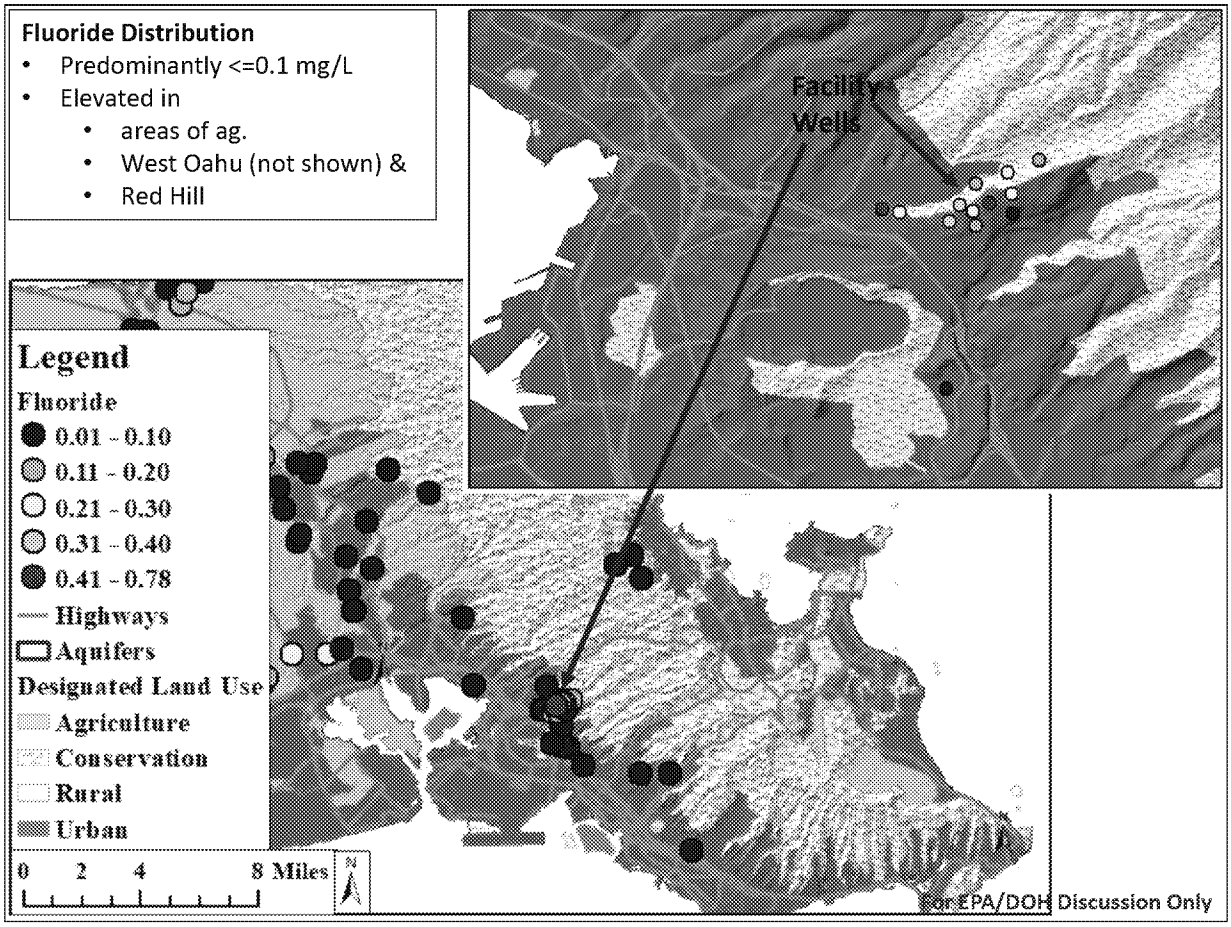
Fluoride Distribution
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• Elevated in
• areas of ag.
• West Oahu (not shown) &
• Red Hill
Facility Wells
Legend
Fluoride
0.01 - 0.10
0.11 - 0.20
0.21 - 0.30
0.31 - 0.40
0.41 - 0.78
Highways
Aquifers
Designated Land Use
Agriculture
Conservation
Rural
Urban
0 2 4 8 Miles
N
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